A Search for Tau Neutrino Oscillation using Holographic Bubble Chamber(Abstracts of Doctral Dissertations)

A Search for Tau Neutrino Oscillation using Holographic Bubble Chamber

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Abstract

Chap. I. Introduction

It is very difficult to measure neutrino mass directly because of its tiny mass and weakness of interaction. Neutrino oscillation has a good sensitivity for measurement of small mass difference between neutrinos. This thesis is the result of ν_τ search using the data of ν_τ experiment at Fermi Laboratory. The originality of this experiment is that holographic technique was used to detect short life particles with high resolution.

Chap. II. Physics of neutrino oscillation

The probability of changing ν_μ to ν_τ is

$$P(\nu_\mu \rightarrow \nu_\tau) = \frac{1}{2} sin^2 2\theta \left(1 - cos\frac{2\pi l \Delta m^2}{2.5p}\right)$$

where l (m) is the flight length of neutrino, p(MeV/c) is the momentum of neutrino, $\Delta m^2 = m_2^2 - m_1^2 (eV/c^2)^2$ is the difference of the power of eigen values of mass, and θ is mixing angle of two eigen states.

Chap. III. Apparatus

The detectors are consist of holographic bubble chamber, tracking counters, and toroid magnet of iron with 2m width. The neutrino interactions in the bubble chamber are recorded with normal cameras, holographic cameras, and tracking counters. Muons are identified using toroid magnet and tracking counters.

Chap. IV. Data acquisition

The momentum of each tracks of neutrino interactions are measured with normal pictures. Neutrino interactions associated with secondary vertex in a short length ($\leq$ 2cm) are examined in holographic picture.

Chap. V. Analysis of neutrino interaction

Interaction events are separated into charged or neutral current by F_{max} method and muon identification using toroid magnet. The energy of neutrino is determined by Bonn method.

Chap. VI. Search for tau lepton

The searched decay channels are as follows; $\tau \rightarrow \mu\nu_\tau\nu_\mu$ and $\tau \rightarrow \nu_\tau + hadron$.

To search for leptonic decay, the following conditions are required in order to reject K and charm meson decay into muon;

1. Daughter particle is identified as muon.
2. There is no muons except the muon from the criterion 1.
3. Pt > 240GeV/c.

And to search for hadronic decay, the following conditions are required in order to reject interactions of hadron;

1. All daughter particles are hadrons.
2. There is no muons.
3. More than one of daughter particles are faster than the particles produced at primary vertex.

The energy of τ produced at primary vertex is almost half energy of ν_τ. Consequently, the daughter particles of τ are expected to be faster than the particles produced at primary vertex.

One candidate of hadronic decay of τ is remained after examing 4413 holographic pictures. Fig.1(a) is the holography picture of the event, and fig.1(b) shows the momentum of each tracks. The expected background events of finding the same topology is estimated as 0.013.

Chap. VII. The result and correction.

After the corrections, total charged current events are 3382 and neutral current events are 1031. The ratio is consistent with other experiments.

Chap. VIII. Conclusion

One candidate of τ is found. In the case that the candidate is τ, we expect 6 to 66 τ's in the samples at 90% C.L. Corresponding allowed region of Δm^2 and $sin^2 2\theta$ is shown in fig. 2.

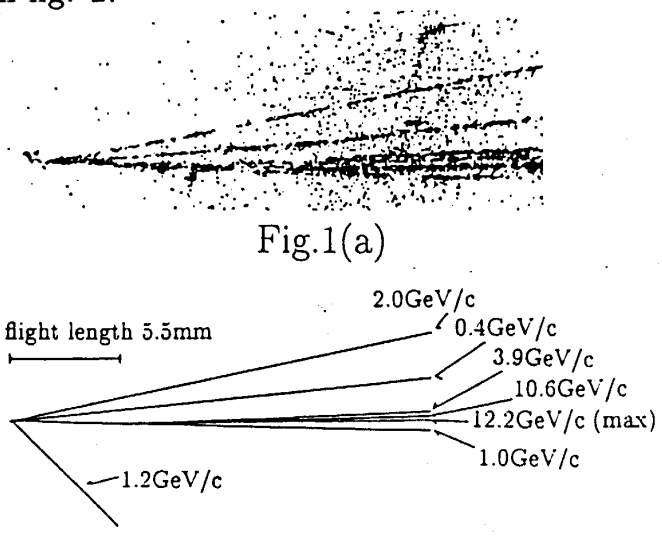

Fig.1(a)

Fig.1(b)

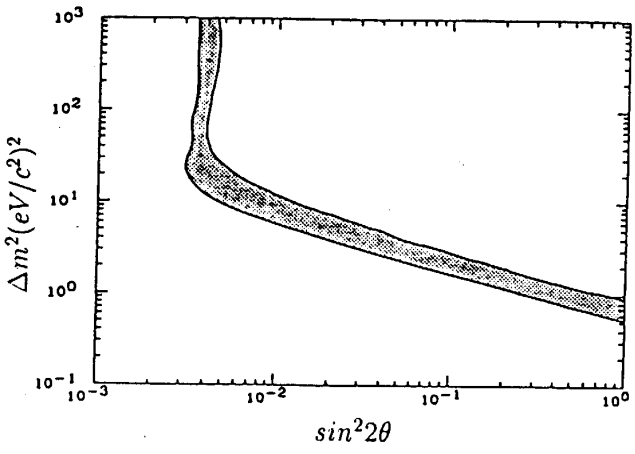

Fig.2